CIÊN. AGRON., 7 (1-2): 59 - 63
DEZEMBRO, 1977 — FORTALEZA-CEARÁ

RELATIONSHIPS BETWEEN WEIGHT, DENSITY, STORABILITY AND GERMINATION CHARACTERISTICS OF RICE SEED.

BASHIR AHMAD AKIL *
FRANCISCO ANTÔNIO XIMENES ARAÚJO **

Several techniques have been developed to increase rice production. Among these high quality seed is considered to be very important. Physical characters like seed color, size, weight density and texture, if and when associated with seed quality, can be used for separating and upgrading of a seed lot. Using a cultivar 'Starbonnet' KAMIL(4) and ROCHA(7) observed a significant increase in both viability and vigor of rice seed as the specific gravity of the seed increased. They also observed early maturity and increased grain yield associated with high seed density. SUNG and DELOUCHE(10) also obtained similar results using three other cultivars of rice. Contradictory results, however, have been encountered in other crop seeds. Larger seed size resulted in increased vigor without any effect on yield in rape(5). In sweatclover, too, larger seeds gave improved emergence and stand, both in fall and spring crops without any consistent effect on foddor tonnage(3). Larger wheat seeds also emerged better but with mixed effect on grain yield(6). Seed size in soybeans(9) had no effect on either plant stand or final performance. Specific gravity rather than size was associated with germination and vigor in sorghum(1).

This study was initiated to verify the effect of seed weight and density on vigor using 'Cica-4', a cultivar of rice grown in Ceará, Brazil. Role of field environment on seed quality characters was also investigated.

MATERIALS AND METHODS

Several hundred samples of rice (*Oryza sativa* L.) seed cultivar 'Cica-4' produced in Icó, Ceará, Brazil, were received during April and May of 1977 in the seed testing laboratory of Universidade Federal Do Ceará. The seed was produced in various irrigated parcels under the seed improvement program of the Departamento Nacional de Obras Contra Secas (DNOCS). Six samples with varying germination capacity (Table 1) were selected at random for this study. The seed was stored at room temperature during the experimental period and the resulting decline in viability was estimated using the standard germination and tetrazolium tests. Fifty huskless seeds were soaked in water overnight and then for 24 hours in 0.2% 2-3-5 triphenyl tetrazolium chloride at 27 C in the dark. Seeds showing clear red embryos were considered viable.

Seed Separation According to Density and Weight: A South Dakota seed blower with opening callibrated 0-100 was employed. Each seed sample was fractioned into chaffy material, light, medium and heavy seed by running the blower for three minutes successi-

* Visiting professor of Fitotecnia Department, Universidade Federal do Ceará, Brasil.
** Agronomy Student, Centro de Ciências Agrárias, Universidade Federal do Ceará, Brazil.

TABLE 1

Germination Capacity of the Rice Seed Samples Used in This Study. Fortaleza, Ce., Br., 1977.

Seed * Sample Number	Harvesting Date	% VIABILITY				% Moist. ***
		June, 77	Oct., 77	Jan., 78	Jan., 78**	Jan., 78
439	March, 77	57	42	22	32	11.00
423	March, 77	92	65	40	52	11.74
383	March, 77	66	54	55	32	11.15
346	March, 77	94	87	78	72	11.91
455	March, 77	93	91	84	76	11.21
2323	Nov., 76	95	86	86	80	11.84

* Seed sample numbers represent analysis nu mbers as recorded in the Seed Testing Laboratory of Universidade Federal do Ceará.

** This is the result of viability test using tetrazolium salt.

*** Percent moisture on dry weight basis. Seeds dried at 105°C for 24 hours.

vely at opening numbers 20, 40 and 65. Only light and heavy seed fractions were saved for this study. Density ratings were assigned to the seed fractions using a floatation method(7) with a saturated solution of sodium chloride (specific gravity 1.203). Density rating of three was allocated to seeds sinking completely to the bottom, two to ones hanging in the middle and one to those still floating on the surface of the solution. Twenty five seeds with three replications were used and the average was reported.

Rate of Emergence And Epicotyl Weight: Fine river sand which passed through a mesh 32 sieve but not a 35 was used for emergence studies. Distilled water measuring 125 ml was added to 4350 g of air dry sand. Throrough mixing was acheived using a small drum shaped hand mixer for a period of five minutes. Moisture variation was still present in the sand sub-samples from 2.34 to 2.44% on dry weight basis.

Plastic freezer boxes (13.5x9x9x cm) were filled three fourth with moist sand. Fifty seeds per box were planted in eight replications at a depth of three centimeters. Thereafter sand was well pressed using a flat wooden plate. The boxes were incubated at 27 C for six days. All emerged epicotyls were counted and removed from the seed base for fresh weight determination.

Accelerated Ageing: Seeds were subjected to wetting and drying cycles. Each cycle comprised of imbibition in water at 43 C for 15 hours and then drying for nine hours at the same temperature. After two or three cycles, 200 seeds in two replications were placed in 15 cm petri dishes on single filter papers moistened with eight milliliters of water. Seeds were incubated at 27 C in the dark for nine days before a final germination count was taken.

RESULTS AND DISCUSSION

The rice seed samples of cultivar 'Cica-4' varied in germination from about 10 to 98% with almost one third of the samples falling in the below 50% range. The major cause of this poor germination was discovered in a separate study (unpublished) to be atrophy of the embryo. Of the samples used in the present study, however, only sample number 439 had considerable percentage of deteriorated embryos (18%).

Germination capacity of the six samples was determined at different dates (Table 1). It could be assumed that all seeds had high germination at the time of harvest and it was the rate of deterioration that differed widely. Temperature during storage fluctuated between 24 and 33 C and relative humidity between 75 and 95%. Samples 439, 423 and 383 deteriorated fast. Germination in sample 439 dropped to a very low level of 22% partly because of accompanied problem of embryo

atrophy. Similiar embryo degeneration may be taking place in other samples but it was not yet apparent. Samples 346, 455 and 2323, however, could be grouped as better storing seeds because they maintained high viability throughout the test period of 10 months.

Equilibrium moisture was calculated just before the start of the wet season and it ranged between 11 and 12% in all samples (Table 1). During the past six months it could have been considerably higher especially during rainy months. SITTISROUG(8) has shown that rice seeds with moisture percentage above 10.5 and storage temperature of 30 C deteriorated fast. Fluctuations in relative humidity were even more detrimental to seed viability. He also indicated that seed deterioration at early stages may not affect standard germination but vigor attributes like seedling growth rate or resistance to accelerated ageing were significantly altered. The storage conditions of the experimental material were rigorous enough to evaluate the comparative storability of the samples. A simple tetrazolium test without adequate standardization was also performed. Based on this test the samples could also be divided into two groups, i.e. the first three poor samples and the later three as retainers of high viability (Table 1). Although all these samples belonged to the same parent seed, the field environment imposed quite varying seed quality characters.

The three better germinating and storing samples were associated with a higher emergence rate, both in heavy and light seed fractions (Table 3). Total epicotyl weight was also consistently greater. Emergence rate together with epicotyl weight gave a fairly good index of inherent superior seed vigor in these samples because both the speed of germination and resistance to the suboptimal sand water system were implied. When these six samples were subjected to an accelerated ageing test, there was a considerable loss of germination in all cases (Table 4). But samples 346, 455 and 2323 outperformed the others, both in heavy and light seed fractions. This leads to a clear conclusion that environment in the field can strongly influnce quality characteristics like viability, storability and general vigor in rice seed.

The seed samples were also separated into heavy and light seed fractions. The one hundred seed weights and density ratings are shown in Table 2. When individual samples were taken into consideration, heavy seed was invariably associated with greater density but this relationship would not hold true among samples. For example, one hundred seed weight and density rating were respectively 4.597 g and 108 in sample 455 while in sample 346, the density rating fell to 70, although the seed weight increased slightly. Since density and weight are pretty much independent seed characters, the South Dakota seed blower was not effective in separating all the samples strictly on the basis of density. However, within samples, a good relationship between weight and density was apparent. Floa-

TABLE 2

Density and Weight Measurements of Light and Heavy Seed Fractions. Fortaleza, Ce., Br., 1977

Seed Sample Number	HEAVY SEED FRACTION		LIGHT SEED FRACTION	
	100 seed wt. (g)	Comparative * density rating	100 seed wt. (g)	Comparative * density rating
439	4.761	72	4.606	59
423	4.766	77	4.522	63
383	4.405	92	4.154	73
346	4.695	70	4.464	64
455	4.597	108	4.445	86
2323	4.854	96	4.677	85

* Higher numbers indicate relatively higher de nsity.

tation method using solutions of different concentrations, has more validity for seed separation on the basis of density(4).

Heavy seed fractions of all samples gave higher emergence and total epicotyl weight (Table 3). Although these seed samples differed in inherent seed quality, they all showed positive association with seed weight and density. Heavier seeds had a better capacity to emerge from relatively less moist but well pressed sand and growth rate was faster giving higher epicotyl yield. It can, therefore, be implied that heavier seeds have better capacity to emerge in the subnormal field conditions. SUNG and DELOUCHE(10) also found that seed vigor in rice in terms of rate of emergence, seedling growth and greenhouse performance was closely related to specific gravity of the seeds. KAMIL(4) and ROCHA(7) have come up with similar results.

It cannot be said with certitude that the heavier seeds have better developed embryos. It would appear probable, however, that weight and density are the result of denser endosperm and covering tissues which constituite more than 96% of seed weight(2). Seed composition differences may be associated with density.

When single epicotyl weights were calculated (Table 3), heavy and light seeds gave similar results. This indicates that vigor difference was maintained in total emergence rather than in growth characteristics of each seedling. However, when seeds were subjected to accelerated ageing, the heavy seeds resisted the treatment better, at least in the three desirable samples (Table 4). In the other samples

TABLE 3

Rate of Emergence and Fresh Epicotyl Weight in Different Rice Seed Fractions. Fortaleza, Ceará, Brazil, 1977.

Seed sample number	HEAVY SEED FRACTION			LIGHT SEED FRACTION		
	Emergence %	Total epicotyl wt. (g)	Single epicotyl wt. (mg)	Emergence %	Total epicotyl wt. (g)	Single epicotyl wt. (mg)
439	22.9	2.010	43.9	19.0	1.161	30.6
423	34.0	2.711	39.9	30.5	2.476	40.6
383	31.3	1.941	31.1	23.5	1.519	32.3
346	46.0	3.278	35.6	41.3	2.955	35.8
455	46.9	3.648	38.9	43.9	3.282	37.4
2323	44.5	2.806	31.5	41.4	2.710	32.7

* Single epicotyl weight was based on seedlings emerged above sand surface.

TABLE 4

Germination Percentage in Rice Seeds as Affec ted by Two or Three Cycles of Wetting and Drying. Fortaleza, Ceará, Brazil, 1977.

Seed sample number	HEAVY SEED FRACTION		LIGHT SEED FRACTION	
	2 cycles *	3 cycles	2 cycles	3 cycles
439	3.3	0.5	3.5	0.3
423	6.8	1.3	7.8	0.0
383	5.5	2.5	6.5	0.0
346	34.5	0.5	29.0	2.3
455	22.8	2.0	17.0	2.0
2323	69.8	19.3	55.8	13.5

* Each cycle consisted of wetting the seed for 15 hours and drying for nine hours at 43°C.

deterioration was so fast that germination approached zero, irrespective of seed density. This is in accordance with KAMIL(4) who found that the vigor of rice seed in terms of cold test and glutamic acid decarboxylase activity was closely associated with specific gravity of the seed.

In this study the importance of heavier seed was shown in the form of better germination, emergence and resistance to deterioration. This reinforces conclusions arrived at various locations by other researchers using different cultivars of rice. It can thus be postulated that the lighter seeds loose their viability first during any prolonged storage. This makes it important to upgrade rice seed quality by eliminating light seeds right before storage. Such seed can assure better stand under field conditions.

SUMÁRIO

No presente trabalho foram estudadas as relações entre armazenagem, germinação, densidade e peso de sementes de arroz *(Oriza sativa* L.) cultivar "Cica 4", produzidas em Icó, Ceará, Brasil. Durante os 10 meses de armazenamento experimental, 3 das amostras perderam a viabilidade, a capacidade de emergência e a resistência ao envelhecimento, enquanto que as outras 3 mantiveram esses atributos, indicando que as condições ambientais em que elas foram cultivadas desempenharam papel importante na determinação da qualidade das sementes.

Em todas as situações, sementes mais pesadas e mais densas mostraram-se superiores às mais leves e menos densas, especialmente ao que diz respeito à taxa de emergência e à resistência ao envelhecimento.

LITERATURE CITED

1. ALVIM, A.L. 1975. Relation of seed size and specific gravity to germination and emergence in sorghum. M.S. Thesis. Mississippi State Univ.
2. ANGLADETTE, A. 1975. El Arroz. Tecnicas Agricolas y Producciones Tropicales. Editorial Blume, Madrid. pages 69-72.
3. HASKINS, F.A. and H.J. GORZ. 1975. Influence of seed size, planting depth and companion crop on emergence and vigor of seedlings in sweatclover. Agron. J. 67: 652-654.
4. KAMIL, J. 1974. Relation of specific gravity of rice seed to laboratory and field performance. Ph.D. Thesis. Mississippi State Univ.
5. MAJOR, D.J. 1977. Influence of seed size on yield and yield components of rape. Agron. J. 69: 541-543.
6. REISENAUER, P.E. and K.J. MORRISON. 1976. The association of seed size and yield on winter wheat (*Triticum aestivum* L.) Agron. Abstr. American Soc. Agron. Page 96.
7. ROCHA, S.B. 1975. Relation of specific gravity of rice seed to laboratory and field performance. M.S. Thesis Mississippi State Univ.
8. SITTISROUG, P. 1970. Deterioration of rice seed in storage and its influence on field performance. Ph.D. Thesis. Mississippi State Univ.
9. SMITH, T.J. and H.M. CAMPER JR. 1975. Effects of seed size on soybean performance. Agron. J. 67: 681-684.
10. SUNG, T.Y. and J.C. DELOUCHE. 1962. Relation of specific gravity to vigor and viability in rice seed. Proc. Ass. Official Seed Analysts. 52: 162-168.